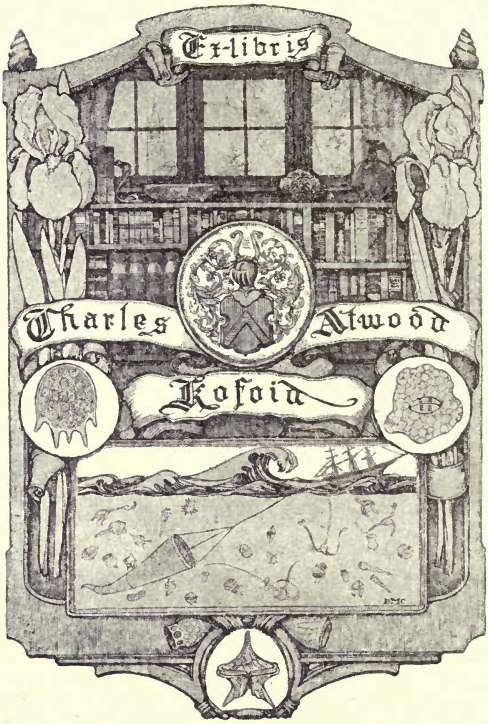
NOTES
ON THE
GEOLOGY
OF
ONONDAGA COUNTY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NOTES

ON THE

GEOLOGY

OF

Onondaga County, N.Y.

EMBRACING

A short description of the various eras, periods and groups, together with statements as to their (1) outcrop, (2) thickness, (3) economic importance, (4) fossils, (5) favorable localities for study.

BY

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PREFATORY NOTE.

The following treatise is practically the same as that submitted to the Syracuse University in June, 1893, for the degree of Master of Philosophy.

The work will be found serviceable in locating and identifying the various geological epochs found in this vicinity. The descriptions are not designed to be sufficient in themselves for identifying specimens. They were added simply to give students, doing field work in our county, a list of the more abundant species. We can, however, by knowing the exact localities in which certain periods, groups and layers occur, together with the specimens found in them, practically, although not positively, identify many of the fossils from the descriptions given.

PHILIP F. SCHNEIDER.

SYRACUSE, N. Y., January, 1894.

UPPER SILURIAN.	1. NIAGARA PERIOD.	1.	Medina Group.*
		2.	Clinton Group.
		3.	Niagara Group.
	2. SALINA PERIOD.	1.	Red Shale.
		2.	Green Shale.
	3. LOWER HELDERBERG.	1.	Waterlime Group.
LOWER DEVONIAN.	1. ORISKANY PERIOD.	1.	Oriskany Sandstone.
	2. CORNIFEROUS.	1.	Onondaga Limestone.
		2.	Corniferous Limestone.
UPPER DEVONIAN.	1. HAMILTON PERIOD.	1.	Marcellus Shale.
		2.	Hamilton Beds.
		3.	Tully Limestone.
		4.	Genesee Slate.
	2. CHEMUNG PERIOD.		
	3. CATSKILL PERIOD.*		

*Not found in our county.

Geology of Onondaga County, N. Y.

INTRODUCTION.

Onondaga County, N. Y., presents to the naturalist one of the finest places in the State for the study of geology, and it is doubtful whether we could find another place of like dimensions anywhere in the United States which would present more features of interest. Not only are the rocks presented here extremely regular, but, dipping slightly as they do, we have successively brought to the surface rocks belonging to the Upper Silurian, and to the Lower and Upper Devonian Ages.

The dip of the rock is slightly west of south, and is about twenty-six feet to the mile, while the outcrop extends in a line running nearly east and west. From the preceding statement it will be seen that the dip is not so slight as to present for study only the unbroken line of one formation, neither is it so great as to compel us to draw our conclusions from an insufficient number of facts; for the periods, with one exception, crop out in lateral bands, which are several miles in breadth.

There are seven different periods found in the county, they are: the Niagara, Salina, Lower Helderberg, Oriskany, Corniferous, Hamilton and Chemung. For convenience of description the various geological periods are subdivided into smaller divisions or groups. These groups are more local in distribution and character than are the larger divisions, and consequently we need not be surprised because we do not find in our county all the groups into which these seven periods are divided. Some of

these groups are found to the east of us, but gradually thin out toward the westward, and have entirely disappeared before reaching us, e. g., the Schoharie Grit, of the Corniferous Period. Again, although we have numerous exposures of the Niagara Period in our county, nevertheless, not all the groups composing it are found here, e. g., the Medina Sandstone, although extensively found in Oswego County, just north of us, is nowhere found exposed in our county.

Of the numerous groups into which these seven periods are divided, fourteen are found in Onondaga County. A complete description of each of these groups will be given later, when we speak more particularly concerning the various periods.

The rocks found in our county belong almost entirely to the class known as stratified rocks. Shale, slate, sandstone and limestone, with the various combinations of these, as shaly limestone, calciferous sandstone, etc., form the prevailing kinds of rock. In addition to these, however, we find a vast quantity of drift scattered over the surface of the county, and mixed with its soil. This drift is composed of many large and medium sized bowlders, together with a great deal of fine sand and gravel. In composition it is extremely variable, some of the bowlders are quartzytes, others are schistose, others micas, etc., but the greater portion are so different from any of the rocks found in place in our county that they must have come from some other source. We also find a great deal of calcareous tufa, or travertine. Not only is this peculiar rock found in many places upon the surface, but in the form of stalactites and stalagmites it also covers the ceilings and floors of those caves found in the county. Marl is another substance that is found to a considerable extent. Many of our lakes are continually depositing it. Serpentine also occurs, although very sparingly. We will speak more

concerning all of these interesting deposits in another portion of our treatise.

In describing the various systems of rocks, we will suppose that we begin our trip in the northeastern part of the county, near Oneida Lake, and by traveling in a southwestern direction we will complete it at the southern boundary, near Skaneateles Lake. Distances, however, will be computed from Syracuse.

Our starting point, at the outlet of Oneida Lake, is about twenty-six feet lower than Syracuse, and is, therefore, 369 feet above tide water. In our trip we will cross the outcrop at nearly right angles. We will first pass over the great level, and after passing a line parallel with the city, we will gradually begin to ascend the hills, while the latter part of our journey will be one constant ascending and descending of hills. The highest elevation which we will find is FABIUS MOUNTAIN, 2,015 feet above tide water.

The scenery of the entire route over which we will pass is extremely picturesque. From the sides of the various hills crystal streams of the purest water trickle down, making the valleys virtually "blossom as the rose." Over the sides of the slopes and down the ravines, dash rapids and cascades of remarkable beauty and size; one of them even competing with the noted Niagara in height of fall. Climbing to the tops of the hills, we will be bountifully repaid for our toil by the beautiful panorama which everywhere meets the eye. It is asserted that from the top of one of the elevations in Pompey seven different counties can be seen.

Our lakes, also, are a source of pardonable pride, and this thesis would be incomplete without a few words concerning some of them. Skaneateles Lake, soon to become the water supply of Syracuse, is a beautiful body of water eighteen miles in length. It has no visible inlet of any size, and its water supply is supposed to be kept up by numerous springs.

The Green Lakes, of which there are several in the county, are also noted far and wide. The bottom of those at Manlius goes down gradually for several yards, and then suddenly breaks off, going straight down to a maximum depth of 180 feet. Their color is a beautiful green, especially so in the bright sunshine, while the water is so clear that trees and rocks lying at considerable depths can be clearly and distinctly seen. These trunks of trees, branches, etc., have for many years excited the curiosity of all beholders, for the persons living in that vicinity positively assert that they have occupied these same positions from the time that the early settlers first saw them. Furthermore, these logs absolutely refuse to decay. An investigation will prove that these stories contain more truth than one might at first suppose. For, besides the fact that these lakes contain quite a strong solution of sulphur, they also deposit marl, which slowly but surely covers and encrusts everything that falls into them, and in this way the form of the substance is preserved. Green Lake, west of Jamesville, differs from those in Manlius, not only in the fact that its color is much darker, more dismal looking and awe inspiring, but also in the fact that it is almost completely surrounded by bold and precipitous walls of limestone, which rise up 200 feet above the surface of the water. Hence, should we happen to see the place for the first time while alone, and also on a dark foreboding day, we could not but be impressed by the extreme stillness of the place, while a single glance down the steep banks and into the dark green water below would fill our hearts with the remarkable feelings, first, of awe and of fear, then of grandeur and sublimity at this wonderful manifestation of the Creator's power in nature.

These lakes have long furnished sources for conjecture, but it seems probable that at some time or other the water contained in them was on a level with the surrounding

surface, and by the forming of caves in the rock underneath, the bottom afterwards sunk down, leaving the lakes thus with their precipitous sides. It is, perhaps, not out of place to mention in this connection that there are several large caves in the surrounding limestone rock; some of these have never been thoroughly explored.

In bringing these introductory remarks to a close, we conclude, not because we have exhausted the list of the natural advantages of our county, but because enough of them have been mentioned to prove the statement with which we started. Hence, we refrain from enumerating others, and pass on to that portion of the work which will treat more particularly about its geological facts and phenomena.

THE SILURIAN AGE.

The Age of Invertebrates, as it is sometimes called, has been subdivided into two parts: the Lower and Upper Silurian Ages. Since the first of these divisions is nowhere found exposed in our county, we will leave it without further notice and say a few words concerning the second.

The Upper Silurian Age is introduced with a limestone formation, has some courses of shale and a large distribution of limestone. It is divided into three periods: the Niagara, Salina and Lower Helderberg. As a whole, the character of these different formations indicates an epoch when there were shallow waters, or even swamps and marshes. The mud-cracks and ripple-marks of the Medina Sandstone, or the immense hopper-shaped pseudomorphs of the Salina Period clearly indicate this.

This age is marked by an abundance of life, especially the marine; land animals probably did not exist, although a few terrestrial plants grew in the swamps and marshes. Vertebrates, however, were still unknown, none of them being found until we come to the Devonian Age.

NIAGARA PERIOD.

This is the first period that we will find in our study of the rocks of this county. As its name would lead us to suppose, it is over a part of the rocks of this period that the noted cataract of America makes its descent. The period is sub-divided into three groups: the Medina, the Clinton and the Niagara.

The Medina Group with its two divisions, the ONEIDA CONGLOMERATE and the MEDINA SANDSTONE, is nowhere exposed in our county. It may, however, be easily studied in Oswego County, just north of us, where it occurs *in situ*.

The Clinton Group is the first division of this period found in our county. It occurs in a narrow strip across our entire northern boundary. Although the group is about eighty feet in thickness, it is, nevertheless, difficult to find good exposures, since it is usually overlaid by several feet of soil and drift.

By digging through the overlying soil near the shores of Oneida Lake, we come to a dark red shale, which forms a part of this group. Broken fragments of the shale will also be found scattered along both banks of Oneida River.

There are also some soft, brittle, greenish-colored shales, constituting a part of this group, that are also found near Oneida Lake. These shales form the bed of the small creek emptying into the river near the outlet of the lake. They also constitute the small knoll in the village of Brewerton on which the Disciples Church stands. The shales are well exposed in the excavation for a cellar just north of the church. On some of the small hillocks, where the overlying soil is thin, the upper surface of this shale is sometimes broken and worked up in ploughing. Several of our northern roads, also, cut through parts of this shale. The road running west from Brewerton has

an exposure just before crossing the Rome, Watertown and Ogdensburg tracks, and another just beyond the railroad.

At Three River Point there is a quantity of shale that was thrown out by the workmen in digging for the foundation of the bridge. The shale is considerably darker than the green shale, and is more properly called a blue shale. It is the only exposure of its kind that I have as yet found in the county.

As a rule, the shales composing this group are thin and readily broken, and are usually largely colored with iron. Indeed, in many places, the iron ore beds found in this group form one of its chief characteristics. Although the group is usually quite fossiliferous, nevertheless, on account of the poor exposures found here, and the small part of the group which they cover, we cannot obtain a representative collection of Clinton fossils from our county. A few small brachiopods, mostly *Spirifers*, the *Strophomena rhomboidalis*, *Strophodonta* (*sp.*), together with numerous specimens of *Fucoides*, are all that I have as yet been able to find.

Since several of the adjoining counties have this shale so much more advantageously exposed, we will find it more satisfactory to study this group at those places, or in the excellent gorges at Rochester, Lockport or Niagara, than to spend much time at the exposures found in our county.

The Niagara Group is the next division of this period, which we will meet by continuing in our course toward the south. It is composed of two divisions, which are known as the Niagara Shale and the Niagara Limestone. It is these two layers that occur at the famous falls. At that place there is some eighty feet of limestone overlying an equal amount of shale. The same formation extends in an easterly direction across our entire State, gradually

growing thinner as it approaches the Hudson River, where it entirely disappears. At the northwestern corner, where this group enters our county, it is slightly thicker than at Bridgeport, on the eastern border, where it leaves the county. The greatest thickness is not more than seven feet, there being four or five feet of limestone overlying some two feet of shale.

There are several places where the group is exposed and quarried, although, like the preceding, it is largely covered with soil and drift. Nevertheless, as the limestone is but a few feet in thickness, and dips toward the south, it forms a sort of ledge which can be traced across the entire county.

This group can be recognized by its dark blue and almost black color, and by its concretionary structure. This structure is characteristic of the formation wherever it is small in quantity. Geodes are common in the rock. They are usually lined with the rhombohedral crystals of carbonate of lime.

The most western exposure in the county is at Dietrich's Quarry, just west of Lysander. The concretionary structure is clearly shown at this place; geodes are very abundant, some of them containing crytals of dolomite. Although the layers are too thin for a good building stone, a neighboring lime-kiln, much dilapidated at present, shows for what purpose the rock has been used.

At Ham's Quarry, two miles northwest of Baldwinsville, we have another exposure. At this place the rock is about four feet in thickness, and was used in making neighboring culverts on the railroad. This limestone contained many *fucoides*.

At Young's Quarry, half a mile northeast of Clay Station, the exposure is not more than two feet in thickness. The rock was darker colored than at Ham's Quarry, neither was it as compact and fine grained. A neighboring bridge

on the Rome, Watertown and Ogdensburg Railroad was built with stone taken from this quarry. The stone at the bridge appeared to be of two kinds, a dark variety, containing *fucoides*, and showing the concretionary structure in a marked degree. These were probably the lower layers. Another variety, harder and more compact, became lighter colored where exposed to the weather.

At Whiting's Quarry, near Cicero, this limestone is quarried to some extent and used for a building stone. It is also burned for lime. Geodes are numerous at this place.

Although the Niagara Group is usually quite fossiliferous, in our county it does not possess that characteristic. *Fucoides* are very abundant; a small *Orthis* and a *Lederditia* are also quite common. Some of the limestone from the town of Clay is reported to be oolitic in character, although I did not find any possessing that characteristic.

This group is important economically, because it furnishes a fairly good building stone to a section of the county, which would otherwise be lacking in good building material. The lime that is obtained from this rock is also important. It can be used for all purposes to which that article is put, except where a very white lime is required. This economic value, however, is limited to that region where the outcrop occurs, and is not important enough to furnish one of the exports of the county.

THE SALINA PERIOD.

The Onondaga Salt Group, as it is sometimes called, is attractive to the casual observer as well as to the geologist. Its pockets of selenite and its seams of satin spar are not only the wonder of our county's inhabitants, but of all its visitors as well. Its immense plaster beds are a welcome factor to such as regard the group merely from a

financial standpoint, while its vast accumulations of salt make it a source of comfort and enjoyment to us all.

The period is divided into two parts, the Lower or Red Shales; and the Upper or Green Shales. Although both names by which the period is known are local, the extent of the rock is not, for it reaches in a strip entirely across our own State, still further westward into Canada, and then again recrosses the boundary separating that country from ours. The beds of rock salt found in Canada and in some of our Central States belong to the same period. The local names were given it because the salt which it contains was discovered, and for a long time worked only at these places.

In our county the Erie Canal may be taken as the dividing line between the two groups. The Red Shales extend across the county in a lateral belt about six miles in breadth and north of the canal; the Green Shales in a similar belt three miles in breadth and south of the canal.

The Lower Group, or Red Shale, is for the most part a soft red marl; mainly composed of thin, uneven and brittle reddish shales, with a few thin layers of sandstone. All of these layers readily crumble when exposed to the atmosphere.

There is an excellent exposure two miles north of the city on the east bank of the Oswego Canal. The exposure is about twenty feet in height, and extends for half a mile. A few layers of green shale, also belonging to this group, occur at the same place. Two other exposures of Red Shale occur on the line of the Rome, Watertown and Ogdensburg Railroad. The first, which is about ten feet in height, occurs just south of Woodard Station; another, considerably higher, occurs on the northern side.

The conditions existing at the time these shales were deposited must have been unfavorable for life, for we do not find a single instance of fossil life in the entire group.

There are many small hills scattered throughout this part of the county, which deserve a word of mention. On account of their form, some of these have become linked in the popular mind with the works of the ancient mound-builders. A study of their structure and composition, however, will readily show that they are collections of material that was probably gathered together and left in heaps by whirlpools existing in the great interior sea that once covered this part of the country. Some of them show evidences of being hills of circumdenudation.

The Red Shales are extensively used in the manufacture of brick. Further than this they have no economic value.

The Upper Group, or Green Shales.—These might more truly be designated the gypseous shales, for their color is not a green throughout; furthermore, there are some layers of green among the Red Shales, and parts of the Clinton Group are also known by that name.

The group is mainly composed of clayey shales, which are, as a rule, quite calcareous. There are also some layers of magnesian limestone. The group varies in thickness from 500 to 700 feet, and, together with the red shales of the Lower Group, makes a maximum thickness of 1,000 feet for the entire period.

Several interesting deposits are found in this group, some of which we will now consider. The first formations which we will find are the gypsum and plaster beds. They occur throughout the entire extent of this group. The plaster rock, which is merely the ordinary name for the gypsum bearing shales, is quarried in large quantities, and used extensively as a fertilizer. Immense beds have been opened up in Camillus, Marcellus and Dewitt, and large quantities have been taken out and exported. Neither are the towns of Manlius, Onondaga and Elbridge lacking in this commodity.

The plaster rock may be examined at the quarries in any of the towns mentioned, or at South Syracuse, formerly Brighton, or on the Split Rock Road, three miles southwest of the city. At the latter place there are some thick seams of satin spar,* which is not rare in any of the beds, although not always in thick seams. A mile northwest of Fayetteville, at the cut on the Chenango Valley Railroad, we find pure white† and the transparent gypsum† in masses, or pockets, in the rock.

In many of the clayey layers overlying the beds of gypsum, we find large hopper-shaped crystals, after salt. These are interesting to us as geologists, because, until recently, they were the only evidence we had that salt ever existed in the rocks of our county. These hopper casts, which are found in many layers of this group, were at one time immense crystals of solid salt. This salt has long since been washed out by percolating waters, leaving only these pseudomorphs in the clayey shale. It is these waters, holding in solution the salt that once filled the hoppers, that have for a long time been pumped up, boiled and evaporated, thus furnishing the salt for which our county is noted. This supposition will appear more plausible when I mention the fact that only three years ago a well was sunk in the southern part of our county, and after passing through the overlying and protecting limestones, pure rock salt was found. Since that time many other wells have been drilled through the overlying rock in the southern part of the county, and in every instance solid salt has been found. According to the statements of the workmen, they drilled through some 1,600 feet of overlying rock, after which a bed of rock salt, varying in thickness from 60 to 200 feet, was found. In Tully Valley there are thirty such wells. Their plan of operation is to allow the water from the Tully Lakes to flow into the

* Fibrous gypsum. † Selenite.

wells, and after it has absorbed the salt, it is forced up and sent on to the Solvay Process Company. As this brine is much stronger than that pumped up near Onondaga Lake, it is probable that it will soon supplant that article altogether in the manufacture of salt.

Still another interesting deposit found in this group is a peculiar calcareous rock called magnesian, or vermicular limestone. It is perforated with a large number of cavities, somewhat resembling worm borings. It is calcareous in composition, and resembles porous tufa more than anything else. The pores are circular and somewhat irregular cavities, often communicating with each other; they extend in almost every direction throughout its mass. The intervening rock is quite solid. The cavities vary in size from those whose diameter is almost infinitesimal to those which are over a quarter of an inch in diameter. Although the rock resembles lava quite closely, and at first one might almost conclude it to be such, nevertheless a little study will clearly prove its mineral origin. The cells are no doubt due to the simultaneous forming of the rock and of some soluble mineral, probably a magnesian salt, which was afterwards washed out, leaving the rock in its present porous condition. There are two masses of this rock, the lower being about twenty feet thick. It is interesting to note that where this mass is found near James street hill, Syracuse, it contains some rocks of a crystalline character, which are serpentines. Serpentine is one of the compounds of magnesia, and since it is found in the vermicular limestone, it would seem more probable that the cavities were formed in the manner suggested. The upper mass of this limestone is much thinner than the lower, often dwindling down to a few feet in thickness.

Vanuxem was one of the first to show that in the Salina Period, as a whole, we have the same deposits as are found

in the salt vats where solar evaporation takes place. In such vats we first find a deposit of oxide of iron, imparting a reddish tint to everything with which it comes in contact. The next deposit is gypsum; and lastly, we have common salt, the magnesium and calcium chlorides remaining in solution. In the Salina Period we have the same state of affairs. First, the Red Shales, colored with iron; second, the beds of gypsum; third, the argillaceous shales with their hopper-shaped pseudomorphs; while above the whole we find the vermicular limestones with their somewhat doubtful traces of the salts of magnesia.

To this period more than to any other, the city of Syracuse is greatly indebted. In the early history of our city, it was the salt found here that gave to Syracuse its remarkable growth, and even at the present time it forms no small part of our wealth. One company, the Solvay Process, uses enormous quantities of salt water in the manufacture of soda and potash, and furnishes employment to 1,500 men. Although the city no longer depends on its trade in salt for its wealth and position, nevertheless the salt industry is still successfully carried on, and Syracuse will, no doubt, always be known as the "City of Salt."

In some places a few fossils are found in the upper layers of this group. Only one, however, a *lederditia*, is known to occur in our county.

LOWER HELDERBERG PERIOD.

In our ramblings over the Upper Group of the Salina Period we have gradually ascended a rising slope, and are now beginning to find ourselves among the low hills of our county, while a little farther to the south they rise still higher, and in the distance seem to uphold the very skies.

The next exposure of rock that we will find, or a glance at the stone fences around us, will readily show that we are in the midst of a limestone formation, and that we have left the shales of the Salina Period in the gentle slope toward the north. These limestones belong to the next great limestone formation, the Lower Helderberg. As but one group of this period, the Waterlime Group, occurs in our county, the other groups having thinned out and disappeared to the east of us, we will speak of this group as the Lower Helderberg Period. It comes to view in many places in the county, and like the remaining periods it can be more easily studied than those already found. The rocks to the north being deeply covered with soil and drift, while those to the south, situated among the hills, are only covered with a thin layer of soil, and can be easily studied in any of the numerous gorges or ravines.

Although in our county the Lower Helderberg is entirely a limestone formation, nevertheless there are two kinds; they are called the blue and the drab. The former is extensively burned in the manufacture of the ordinary quicklime, and the latter for the waterlime of commerce. Immense quantities of both kinds are packed, either in sacks or barrels, and transported by the carload to all parts of the country. Owing to the fact that hydraulic cement, so named because it will form a cement which sets under water, is made in large quantities from the waterlime-stone, the drab is often called hydraulic limestone.

The two kinds usually occur conjointly, being in alternate layers. At Behan's Quarry, near Manlius village, there are two alternate layers of each, neither being more than four feet thick. The entire exposure at this place is about sixteen feet in thickness. At Alvord's Quarry, but a short distance from the preceding, we have the same state of affairs. In the perpendicular face of rock at the

Dorwin Quarry there are about eight feet of waterlime-stone overlying twenty-five feet of blue. At Britton's Quarry, on the eastern ridge of Onondaga Valley, we have two layers each of blue and of drab. At Hibbard's and Russel's Quarries, both near the Britton Quarry, we have practically the same state of affairs as at that place.

The blue limestone is full of fossils, while the drab is characteristic in being wholly destitute of them. But there is a compensating quality here for the geologist, for many of the seams of this rock are lined with the rhombohedral crystals of fluor-spar and of calcite. At Alvord's Quarry, Manlius, we often find these beautiful crystals lining the cavities of small geodes. At other places such geodes are rare, the crystals being generally found in the seams of the rock. Occasionally calcite crystals are also found in the blue limestone. Many of the layers also contain a peculiar form called lignilite, or epsomite. It resembles the suture joints in the skull, except that the individual sutures are generally, though not always, much longer.

We have found the following fossils in the Lower Helderberg of our county.

Tentaculites irregularis. A pteropod found sparingly in the lower layers.

Holopea antiqua. A small univalve usually about a half inch in height. Good specimens are rare, although they are common in the form of casts. The best specimens are found near Skaneateles.

Replaced Columnaria is also abundant. It is usually found in large masses, and is common in all the layers.

BRACHIOPODS.

Spirifer vanuxemi. A small but exceedingly abundant fossil.

Strophodonta varistriata. Is somewhat larger than

the preceding, with a smoother surface. Both are extremely abundant, and are found at all the localities mentioned.

Merista sulcata. Not as common as the preceding. Found at Britton's Quarry.

LAMELLIBRANCHS.

Pterinea rugosa. This specimen is quite abundant, being found at nearly all the quarries mentioned.

Avicula communis and *Avicula umbonata* are two lamellibranchs that are rarely met with in our county. They are found in the lower layers.

CRUSTACEANS.

Eurypterus remipes represents a new family that makes its appearance with this period. It is quite abundant in some of the counties east of us, but we have the only known specimen that has as yet been found in our county. As this fossil is found in similar layers of the Waterlime Group to the east and to the west of us, it is reasonable to suppose that it exists somewhere in the rocks of this formation in our county. The specimen mentioned was picked up amid some loose material and drift in Onondaga Valley, and it is possible that it may have drifted in from one of the adjoining counties.

Lederditia alta is another crustacean found in this period. It is an ostracoid, and very abundant. Specimens a fourth of an inch in length are not rare. Dana says of it, "The *Lederditia alta* of this period is unusually large for its family, modern ostracoids seldom exceeding a twelfth of an inch in length."

This period may be advantageously studied at the following places:

(1) Dorwin Springs, (2) Split Rock, (3) Britton's, (4) Hibbard's, (5) Russell's Quarries, the three latter being on

the upper road to Jamesville, near the cross-road going to Onondaga Valley, (6) Carrigan's Quarry, Skaneateles, (7) Behan's Quarry, Manlius, (8) Alvord's Quarry, Manlius, (9) at the falls three-fourths of a mile south of Manlius, on the East Branch, and one mile southwest of Manlius, on the West Branch of Limestone Creek.

The economic importance of this group is considerable, neither is it limited to the immediate vicinity. Vast quantities of quicklime and of waterlime are manufactured and sent to all parts of the country. The blue limestone makes a good building stone, and is used extensively for that purpose. Large quantities of crushed stone are also exported. This article can be used for many purposes, the most important of which is in making solid foundations for the modern asphalt and macadamized pavements. It is also used extensively in the manufacture of the cement sidewalks which have recently become so popular. In the towns of Dewitt and Manlius, where the lower measures of the group occur, it is often used for farm fences. It is well adapted to this purpose, as the comparatively thin layers are easily broken into oblong blocks, which a little skill will readily convert into good fences.

THE DEVONIAN AGE.

With the next period a new era, the Devonian begins. Like the Silurian, it has sometimes been divided into two parts, the Lower and Upper Devonian Ages. These have usually been subdivided as follows:

Lower Devonian.	1. Oriskany Period. 2. Corniferous Period.
Upper Devonian.	1. Hamilton Period. 2. Chemung Period. 3. Catskill Period.

The system commences with a sandstone formation, after which it is mostly composed of limestone and shale,

with some sandstone. During this era, land plants became abundant, fishes swarmed in the seas, and corals, crinoids, brachiopods, lamellibranchs and gasteropods continued in undiminished numbers. Toward the latter part of the era, plants became so abundant as to foreshadow the Carboniferous Age, while the large deposits of carbonaceous shale have more than once led to a fruitless search for coal.

THE ORISKANY PERIOD.

While studying the rocks of the Lower Helderberg Period, we sometimes found that they were overlaid by a thin deposit of coarse sandstone, which we immediately recognized as being different from anything which we have as yet met. If the character of this sandstone would leave us in doubt as to its identity, a glance at the profusion of its fossils ought immediately to tell us that it is the first member of the Devonian Age, the Oriskany Sandstone.

This period has sometimes been referred to the Silurian Age; in fact, many geologists have at one time placed it in the Silurian, and at another time in the Devonian Age. This is due to the fact that in some localities its fossils are related to those of the preceding group, and at other localities to those of the following. Since this is the case, it will be safe to say that this sandstone forms the passage beds between the two ages. At the present time, however, the tendency is to place it in the Devonian Age.

The rock is a very rough, dark, and oftentimes rust-colored sandstone. Where it has been protected from the weather, however, it sometimes occurs as a clear white sandstone. Its thickness varies from a few inches to some thirty feet.

The first place where we find this period in our county is at the Britton Quarries, three miles south of Syracuse,

on the upper road to Jamesville. The quarry, lying among the hills to the east of Onondaga Valley, is but a short distance from the lime-kiln, which is usually reckoned as being midway between Jamesville and Syracuse. The sandstone occurs in a thin layer, not more than thirty inches in thickness. As this quarry is quite extensive, covering more than half a square mile, in some parts the sandstone comes to the surface, while in others this is overlaid by the Corniferous Limestone. As this sandstone has no economic value, it is often gathered up as waste by the quarrymen and thrown into large heaps. Many of these heaps are excellent collecting grounds. Where the sandstone comes to the surface it is much discolored, and is often so disintegrated that it crumbles into sand.

Another place where this sandstone occurs is near Dorwin Springs. This is five miles southwest of Syracuse, and is midway between that place and the village of South Onondaga. It is in the ridge of hills west of Onondaga Valley, and almost directly opposite the Britton Quarries. The exposure of Oriskany occurs about half way up the hill; it overlies the Lower Helderberg, which is quarried at the base of the hill, and is in turn itself overlaid by the rocks of the Corniferous Period. Its thickness on the slope of this hill is about eight feet, the perpendicular distance or real thickness being about six feet. The rock is very similar to that at Britton's Quarry, a rough sandstone largely colored by iron. About one foot from the top, and near the transition to the Corniferous, the rock is not so highly colored, having more the color and nature of limestone, although mainly arenaceous. The rock is full of fossils, especially the lower layers, though it is often difficult to obtain them from the rock *in situ*. Many large bowlders, some of them four or five feet in diameter, have become detached from the mass of the rock, and by demolishing

these and other smaller bowlders, which one will find in the surrounding stone fences, a representative collection of this period's fossils can readily be obtained.

In the bluff east of the Glenside Mills, Skaneateles, this rock again occurs. At this place it is about twenty feet in thickness, but since the exposure is in a bluff which is not easily accessible, it does not form as favorable a place for collecting specimens as some of the other places mentioned. Another exposure will be found in the southern part of the town of Elbridge, where the sandstone is about thirty feet in thickness. This represents the maximum thickness exposed anywhere in our county. The other extreme will be found in Manlius, where the rock is but a few inches in thickness, or at Split Rock, where it has almost entirely disappeared.

The following fossils are found in this period:

BRACHIOPODS.

Spirifer arenosus, a large and course brachiopod is the most abundant. The spirifer itself is not very common, but the cast is extremely so. Almost any large piece of the sandstone, chosen at random, when broken open will reveal parts of it. Although the spirifer and its cast are perceptibly different, they would not be mistaken for different genera or species.

The *Orthis hippiraonyx* is another bivalve of common occurrence, although not as abundant as the preceding. The lower valve bears a striking resemblance to a colt's foot, and is commonly called by that name.

The *Orthis musculosa*, another species of the same genus, is usually smaller than the preceding, and not as abundant.

The *Merista lata* is another brachiopod which is plentiful but not abundant. The casts of this specimen are quite unlike either of the valves, which are also slightly different.

The *Rensselaria ovoides* is a much larger and more handsome brachiopod than any of the others. It is only occasionally found.

Among Gasteropods we have found a large *Platyceras nodosum*, and a smaller univalve, the *Platyostoma ventricosa.*

Economic Value. In some places the sand has been used for manufacturing glass. It is also reported that when the Erie Canal was constructed that blocks of the Oriskany Sandstone were used in the locks at Jordan, and it is said to have worn very well for a rock of that character. Inasmuch as iron exists quite plentifully in the rock, quantities of it have frequently been obtained for the purpose of smelting. Nevertheless the difficulties of extraction, together with the attendant expense, have heretofore proved insurmountable obstacles to a successful enterprise.

CORNIFEROUS PERIOD.

In nearly all the places where we found the Oriskany Sandstone it was overlaid by a very tough limestone. This protected it, not only from such destructive agencies as air, frost and moisture, but also from the attacks of enthusiastic geologists, who might otherwise have soon appropriated our small allowance of that interesting period.

The limestone is the last of the great limestone formations, the Corniferous. It has sometimes been called the Upper Helderberg Group to distinguish it from the Lower. It is found very abundantly in our county, and is chiefly a limestone formation. The period has been divided into three groups: the Schoharie Grit, Caudi-Gauli Grit and the Corniferous Limestone. Only the last of these is found in our county. This has usually been subdivided into three divisions, the Onondaga, the Corniferous, and the Seneca Limestones. Although these divisions are all

limestones, they vary slightly in structure and composition. While all the strata are fossiliferous, it is often difficult to obtain good specimens on account of the extreme toughness of several of the layers. Both plants and animals are represented in these fossil remains. Fishes first make their appearance in this period. Sponges, corals, crinoids, brachiopods, gasteropods, lamellibranchs, cephalopods and trilobites are common, while plants are represented by ferns and lycopods. Many of the courses of rock furnish excellent building stone, and some are burned for the manufacture of lime.

The Onondaga Limestone.—The first group of this period which we will discuss is the far-famed Onondaga Limestone. In color it is gray; in structure, tough and crystalline; in durability it approaches granite, which it is often said to resemble. If it has once been carefully noted it will henceforth be easily recognized. It is capable of taking a very excellent polish, which, with its other qualities, makes it a valuable substitute for granite and marble in monuments, tombstones, ornamental trimmings, etc. In these forms it is often sold by local dealers for granite. As a building stone it is unsurpassed, and not only has it the local reputation of being one of the finest building stones in the country, but is known as such all over the United States. For several years past, however, competition has sprung up, its rivals being two handsome sandstones. Owing to an unlimited amount of advertising these have gained a considerable amount of public attention and praise. In our own city, several large buildings have been constructed from these materials, and we heartily join in the popular voice which has called them "handsome." Whether they will prove superior to the Onondaga Limestone, as their promoters have often maintained, or whether they will eventually occupy an inferior position to the limestone, which on account of its

durability, its resistance of pressure, of atmospheric agencies, etc., etc., has gained a national reputation extending through half a century, is at present only a matter of conjecture.

A few of the structures built of this limestone are: the new Cathedrals of St. Paul and St. Mary, the new Government Building and the new City Hall. Of those which have stood the storms of a quarter of a century we mention the Court House, the Onondaga County Savings Bank, and the Hall of Languages of Syracuse University. The continual and growing demand for the Onondaga Limestone, and the many large public buildings that are being constructed of it, are ample evidences of its continued popularity.

As many of the layers are very fossiliferous, if these be taken, ground smooth and polished, not only will the fossils first seen be brought out more clearly, but others, which were at first invisible, will be distinctly brought to view. When burned this rock furnishes an extremely pure white lime. Formerly it was burned in large quantities for this purpose, and always brought a price largely in advance of the amount paid for the ordinary article. For a number of years past, however, this industry has not been carried on very extensively. This is probably due to the fact that this particular rock brings more money with less trouble as a building stone than as lime.

Although this group is abundant in fossils, none of them are limited to it alone, but are distributed throughout the entire period. We will, therefore, leave the discussion of its fossils until we speak of those of the entire period.

This group can be easily studied at Split Rock Quarry, five miles southwest of Syracuse; at the Indian Reservation, six miles south of the city; at the Glenside Mills, Skaneateles; at the quarries north of Skaneateles Falls;

at Green Lake, Jamesville; in the southern part of Manlius, and in the northern part of Pompey.

The Corniferous Group differs from the Onondaga Limestone, in that it has scattered throughout its mass, nodules of flint, or hornstone. Frequently these nodules are arranged in layers. So plentiful are these particles of flint, that not only has this group but the entire period been named from this circumstance. These nodules of hornstone are the remains of multitudes of small organisms; as, diatoms and desmids. Should you carefully examine a small piece of hornstone under the microscope you would find it to be largely composed of the siliceous remains of plants and animals. Diatomaceous shells and spicules of sponges are the most common. As this hornstone is mainly siliceous and much harder than the surrounding rock, it often happens that where it has been exposed to the weather, large masses will be found protruding from the parent rock. Since it is also slightly darker than the rest of the rock, such protrusions often appear in peculiar and grotesque shapes, which are distinctly visible. On account of the occurrence of these masses in the Corniferous and Seneca Groups, and because the limestone itself has begun to deteriorate, for it no longer has the crystalline character of the Onondaga Limestone, it contains foreign matter, has a tendency to become shaly, aud shows in many ways its inferiority, therefore the two latter divisions have no very great economic value. Although it is almost valueless for practical purposes, it is, nevertheless, interesting to us on account of the many evidences of former life which it contains.

The Seneca Group closely resembles the preceding, both in structure and composition, and is not separated from it by any distinct line of division. It was made a new group because it contained a particular fossil, the *Strophemena lincata*, in great abundance. For a long

time none of these specimens were found in the preceding groups, and this was supposed to be a sufficient reason for making the upper layers a new division. A more diligent search, however, shows that these fossils also occur, although sparingly, in the other groups; since this is so, and as the line of division between the groups is not distinct, they have very properly been designated as one group. In some places these upper layers contain courses of very good limestone. This is true of the western part of our county. For instance, in Marcellus this limestone is often quarried and used for building purposes; occasionally it is burnt for lime, although the product obtained is not very pure.

The Corniferous Limestone and the Seneca, also, if we persist in retaining this subdivision, may be studied at the following places: just east of Manlius Village, south of Jamesville, and at the quarries north of Onondaga Hill, north of Skaneateles Falls, and south of Marcellus.

Unless otherwise indicated, the following fossils are found throughout this entire period.

PORIFERA.

Petra Spongia, a small globular sponge about the size of an ordinary marble. Abundant in the shaly layer overlying the Onondaga.

COELENTERATA.

In several places this formation consists almost entirely of ancient coral reefs. There are several species of corals found in it. Stag-horn and cup corals are the most abundant. *Heliophyllum Halli* is a common variety. Favosites, or honey-comb coral, is also quite common. The most abundant species are the *Favosites Goldfussi* and *F. Gothlandicus.*

ECHINODERMATA.

The crinoidea, at least one family of them, are said to be especially partial to New York State. Not only is this true in regard to the vast number of crinoids found, but also in regard to the size which many of them have attained. In our county crinoid stems are the only parts found. These, however, grew to be quite large, specimens half an inch in diameter being common, while those an inch in diameter are not rare. Their length also is remarkable. It is not a strange thing to see them extending across the entire breadth of some of our stone sidewalks, often several feet in length. Since these crinoids are not found entire, but the stems only, there has been some doubt as exactly where to classify them. In the early State reports they are called *Encinitus Lavis.* Some of these stems are very beautiful, having a radiating structure extending from a central star, circle or polygon. Usually these stems are the same color as the limestone, but occasionally specimens are found having a very delicate pink color; the latter are, of course, the more highly prized. This variety is often found at Split Rock.

GASTEROPODA.

This family is well represented in the Corniferous Period, and is, no doubt, more abundant in that formation in our county than anywhere else. The particular layer that abounds in these specimens is an impure shaly mass overlying the Onondaga Limestone. It is well exposed at the Indian Reservation. In referring to this layer at the Reservation, State Geologist Hall says: "This shale has probably afforded twenty times as many specimens (of *Platyostoma turbinata*) as all the other localities in the State." Again, in commenting upon the great variety in genera and species found at this place, he says: "It would

appear that the physical conditions favoring the abundant production of individuals, has, at the same time, favored a degree of variation *unknown* under conditions existing elsewhere." So great is this variation in some of them that, in not a few instances, it is at first difficult to recognize the characteristics of the gasteropods.

We have found the following species especially abundant: *Platyceras dumosum*, *P. rarispinum*, *P. perplexum*, *P. rictum*, *P. attenuatum*, *P. conicum*. Also *Platyostoma lineata*, *P. pleurotoma*, *P. turbinata*, variety *P. cochleata*. Two other species abundant at this place, but also found throughout the entire period, are: *Pleurotomaria lucina* and *Strophostylus varians*.

Gyroceras undulatum. A large cephalopod often measuring six inches in diameter, is quite abundant in many of the layers. It is rolled in one plane, the volutions may be in contact or open, and a transverse section is elliptical.

BRACHIOPODA.

The *Atrypa reticularis* is a handsome brachiopod found sparingly in this period, but more abundant in some of the others, especially in the Hamilton. It is well to note that the specimens from the Corniferous are larger and better preserved than those from some of the other periods. It is abundant in the shaly layer at the Indian Reservation.

Strophomena rhomboidalis is abundant in most of the layers. Oftentimes the fossil form is colored red, making it very distinct and prominent.

Strophomena rugosa is usually regarded as a variety of the preceding. It differs from it in that it has but eight ridges, while the preceding usually has eighteen.

Orthis eboracensis is a small but very abundant brachiopod. Both valves are usually found together.

Spirifer raricosta. A medium sized spirifer common in the Onondaga Limestone. It has been described under the names *Spirifer undulatum*, *S. raricosta*, *Delthyris undulatum.*

CRUSTACEA.

Phacops bufo. A small trilobite occasionally found.

Odontocephalus selenurus. Another which is characteristic of this period, and is quite abundant. As its name implies, it is the spiked-head, moon-shaped tail, trilobite. Although parts of this specimen are very common, especially the pigidium, whole specimens are rare. Owing to this fact, it was long thought that the head and tail portions were parts of two different trilobites, and they were accordingly given different names. For some time the head was known as the *Calymene odontocephalus*, and the tail as the *Asaphus selenurus*, but later an entire specimen was found, and it was accordingly known as the *Odontocephalus selenurus.*

The *Dalmanites* (*Coronura*) *Myrmecophorus* is a large and exceedingly beautiful trilobite existing somewhere in this period. The exact layer is as yet unknown. No whole specimen has yet been found, but the few fragments all show that it is large and handsome. An entire specimen of the same proportions as the largest fragment would indicate a trilobite over a foot in length.

VERTEBRATA.

Fish spines are the only parts which have as yet been found in our county. In some of the counties east of us, however, the fossil form of the entire fish has been found.

HAMILTON PERIOD.

The next period which we find in our trip toward the south is the Hamilton. This period consists of sand-

stones, shales and some layers of limestone. The seas which existed at the time these layers were formed, must have abounded with life, for the remains of corals, brachiopods and lamellibranchs are found in the greatest profusion. Occasionally the remains of the earliest fishes are found, while terrestial plants are now more numerous than heretofore. Insects, too, make their appearance in this period.

The four groups into which this period has been divided, the Marcellus Shale, the Hamilton Beds, the Tully Limestone and the Genesee Slate, are all well represented in our county. Two of them, the Marcellus Shale and the Tully Limestone, here reach their culmination.

The Marcellus Shale.—Directly succeeding the upper layers of the Corniferous Limestone, we find an extremely soft, black, fine-grained shale with an occasional layer of limestone. This is the oldest member of the Hamilton Period, the Marcellus Shale. It can readily be distinguished from any of the preceding groups by its black color, by the extreme thinness of the shale, and by the fact that when rubbed it gives off a bituminous odor. As stated, it is for the most part a thin, slaty and extremely brittle mass, which quickly disintegrates when exposed to the weather. Nevertheless, a few feet above the base of the shale a thin layer of limestone, usually not more than two or three feet in thickness, occurs. This limestone is very impure, and readily breaks up into small irregular fragments when hit with the hammer. It is often called by the popular name, "shell rock", not because it contains an abundance of shells, but because to the popular mind the small irregular masses into which it readily breaks somewhat resemble shelled corn. Local geologists, however, term this rock by a more appropriate name, the Goniatite Limestone. The shales in the upper

part of this group are not as highly colored as they are in the lower part, and they gradually become dark bluish in color, closely resembling the lower layers of the Hamilton Beds, into which they gradate. Indeed, it is often difficult to tell the exact line of division between the groups.

The group extends in an unbroken line across the entire breadth of the county. It is exposed in many of the ravines and waterfalls in the towns of Manlius, Pompey, Lafayette, Onondaga, Marcellus and Skaneateles.

The rock attains its maximum thickness in the town of Marcellus, where it is about 200 feet thick. The lower shales are exposed to the east of the village, while the upper layers may be found to the west and south. There is a fault in the rock here, and another near Manlius. Both are extremely local, however. It is also interesting to note, that in the midst of the shale at the latter place there is a black limestone, varying in thickness from five to ten feet. It is weathered into huge rough masses, and has sometimes been worked and used for rough building purposes. It also makes an excellent cement. This mass of limestone, as well as the concretions of calcareous matter, known as septaria, which are found scattered throughout the shales of the entire group, clearly indicate that the mud of which the group was composed contained throughout its mass calcareous material in varying proportions. Where the amount was small, it congregated into the oval masses or septaria; where it was large, as at Manlius, limestone was formed. The septaria are oval, flattened, or oblong bodies, usually crossed by numerous seams, which are filled with foreign matter. They are calcareous, and were probably deposited along with the material of the shaly matter, the calcareous portion separating from the rest of the mass and uniting. In drying and shrinking, these cracks, or septa, were formed. These

were afterwards filled with crystalline matter; as, calcite, sulphate of strontian, etc. Sometimes these septaria seem to have aggregated around a nodule of iron pyrites, a shell, or some other particle of matter, for on being broken open such bodies are found within. Occasionally they contain cavities lined with crystals.

Since we often find particles of coal, and a small percentage of combustible material, distributed throughout the mass of this shale, numerous excavations have been made in it with the hope of finding sufficient quantities of these materials to make mining profitable. We occasionally hear of fortune seekers who are wasting their time and money in the vain hope of finding coal in this shale. *In vain*, because the limited amount of vegetation at this time clearly indicates that all such expenditures are in vain, and that the search for coal must necessarily be fruitless.

It has, however, an indirect economic value, for by its disintegration our county receives a valuable addition to its soil. This is all the more valuable, because the soil as fast as it is formed on the sides and summits of our southern hills, is transported by the action of our streams to the valleys and levels beneath, and thus serves for our common benefit.

FOSSILS.

Should we say that the Marcellus Shale is almost destitute of fossils, it is not at all likely that we would be contradicted by anyone who has hunted for specimens in the black shales which compose the greater part of this group. Indeed, this part of the group is almost non-fossiliferous, for it is only after the shales have begun to change to the thicker and harder layers of the Hamilton Beds that fossils appear. But, to the geologist, there is a part of the group vastly more interesting and important than the

parts already named. I refer to the thin calcareous mass near the base of the shale, which is commonly known as the Goniatite Limestone. The interest in this layer is not due to any great abundance in the variety of its specimens, for the number of varieties is small, even though the layer is well described by saying that it virtually abounds in its peculiar fossils. But, as its name implies, it is in this layer of the Marcellus Shale that the new and extremely interesting family of goniatites first makes its appearance. In fact the cephalopods as a class are very well represented in this layer, for, besides the goniatites, we find several species of orthoceras and of nautilus.

Orthoceras Marcellense. This fossil may be recognized by its long straight shell, which gradually expands from the apex to the aperture. A transverse section is circular, and is pierced by a slightly excentric siphuncle, situated on the ventral side.

It is common in nearly all the places where the Goniatite Limestone occurs. Good exposures for obtaining specimens are southwest of Manlius, east of Jamesville, and east of Marcellus.

Orthoceras aptum differs from the preceding in that the septa are more frequent, the sutures are curved and oblique, and the entire appearance of the shell is more tapering, due to its more gradual enlargement. Although not as abundant as the preceding, it is, nevertheless, often found at the above mentioned places.

Discites Marcellensis is the noted *Goniatites Marcellensis* of the early reports, and is still occasionally called by that name. For a long time, however, it has been classified as a nautilus, but on account of a closer relationship to the goniatites than the nautilus usually shows, some paleontologists have placed it in the new class, *Discites*. We consider it a good classification, for the

specimen closely resembles the early goniatites, and is frequently mistaken for one of them.

Nautilus liratus and *N. buccinum*, two species of nautilus proper, are also found in this limestone.

Goniatites Vanuxemi, the goniatite proper found in this group, is quite a handsome specimen. It often attains a large size, specimens a foot in diameter are not rare, but on account of the friable nature of the limestone it is not always easy to obtain entire specimens.

Some of the other fossils found in this group are the gasteropods: *Pleurotomaria regulata*, *Euomphalus planodiscus* and *Macrochilina Hebe*. The cephalopods: *Gomphoceras Conradi*, *G. Fischeri*, *G. oviforme;* and a pteropod, *Coleolus acicula*. A handsome little trilobite, the *Proetus Haldemani*, is also found associated with these fossils. These specimens are all found in the Goniatite Limestone.

The Hamilton Group.—As has already been stated, the shales composing the upper part of the Marcellus Group gradually become harder in texture and lighter in color, until they have gradually changed into the dark blue shales everywhere recognized as the Hamilton Beds, thus leaving little or no line of demarkation between the groups. In some places, however, there seems to be a more abrupt change, which is noted more especially on account of the abundance of fossils that suddenly appear than by any distinct change in the rock. In other places even the fossils begin in shales which are without doubt Marcellus, and gradually become more abundant, until at last we find them in the greatest profusion in rocks that are clearly Hamilton. Nevertheless, it is impossible to say that at any one point the one group begins and the other ends.

This group, which is quite extensive, includes a variety of rocks occurring between the Marcellus Shale and the

Tully Limestone. These beds vary in thickness from 300 to 700 feet. The kinds that are most persistent are shale, sandstone and slate, usually occurring in the order mentioned, although the variety of ways in which they are combined makes it a difficult matter to try to enumerate their order of succession.

Where the division between this group and the preceding is most marked, we find that the lower layers are a dark and somewhat slaty shale, which in some places contains a few feet of dark colored limestone. This shale is usually quite fossiliferous. It crops out just northeast of Skaneateles, on the road between that place and Marcellus, and again just north of Pompey Hill. As we move farther toward the south we find that this shale has changed to a less fissile and more calcareous shale, by which it is overlaid. The latter has sometimes been called the Skaneateles Shale, although the name is not generally recognized. Even when used it has sometimes been made to designate various parts of the group, or even the entire group. We next come to a much harder variety of shale, also fossiliferous, which in its turn is overlaid by a hard layer of sandstone. In some places this appears as a shaly sandstone. Its color is usually brown, and where weathered a yellowish brown. Lastly, this sandstone is overlaid by another hard variety of shale, which completes the group. These divisions are not always easily distinguishable, nor are they persistent for the entire county. The enumeration applies more particularly to the eastern part in the towns of Pompey and Fabius. Toward the western part of the county there is more calcareous and less arenaceous matter. The whole situation may be easily summed up by saying, that while the shales and sandstones predominate an occasional layer of limestone is found.

For delightful field study there is no group in our county as interesting as the one under consideration.

Here the paleontologist can find specimens to his heart's content. Every stratum, with the exception of one fine grained sandstone, is literally filled with fossils. Furthermore, our share of this group is very extensive. It covers the greater part of the towns of Pompey, Lafayette and Otisco, and no small part of Onondaga, Marcellus, Fabius, Tully, Spafford and Skaneateles. Another favorable circumstance connected with this group is that in the towns just mentioned we find many small ravines and gorges. These cut through the hillsides, which are largely composed of Hamilton rock, and run down to meet, at right angles, the longitudinal north and south valleys into which the county is divided. These ravines furnish excellent places for studying the stratagraphical and paleontological characteristics of this group. Still another favorable circumstance is that the rocks are so arranged, the harder shales and sandstones overlying the softer shales, and all in turn being overlaid by the Tully Limestone, that we have just the conditions necessary for the formation of waterfalls. Consequently, we will find numerous beautiful falls throughout this part of our trip.

As a few of the inviting places, we mention the steep ravines near Amber and South Onondaga, together with numerous others in Tully, Otisco and Spafford. As a few of the best falls for practical study we mention Pratt's Falls, Pompey, where there is a fall of water claimed to be 166 feet in height; Buhr's Falls, Delphi, 64 feet; Tinker's Falls, 60 feet; and Gamble's Falls. The rocky shores of Skaneateles Lake, and the numberless gullies and ravines leading down to them, furnish still other advantageous places for the study of this group. In the ancient coral reef at Staghorn Point we have an excellent place for studying corals. There are fifteen species of cyathaphylloid corals found here, together with numerous species of other families. This one case will serve as an example of

the variety and profusion of the fossils found in this group. The study and classification of all its different forms would give ample employment to an enterprising student for no small portion of his lifetime.

If we overlook the fact that some of the sandstones of this group have been used for building purposes, and that the entire group furnishes a valuable addition to our soil, we can say that it has no economic importance.

FOSSILS.

Heliophyllum Halli is the most abundant of the cyathophylloid corals, although, as already stated, there are many different species. Most of these are extremely abundant, and in some places constitute a large part of the rock.

Other genera represented are: *Zaphrentis*, *Cyathophyllum*, *Favosites*, *Taeniopora*, *Stictopora* and *Reptaria*.

Gasteropods.—If it is possible for any family to be more abundant than the corals, we must reserve that place of honor for the gasteropods. Many of the layers are just filled with *Pleurotomaria*, and with a little labor almost any number of them may be secured.

Pleurotomaria sulcomarginata is the most abundant. It can be distinguished from all the others by the two distinct revolving carina of each volution, which are crossed by numerous well marked striae. This species is said to be more abundant at Pratt's Falls and Delphi in our county than at any other locality in the State.

P. rotalia. Although this species is quite similar to the preceding, it can be distinguished from it by its shorter spire and more convex volutions, which are less distinctly marked by striae. It is abundant in the harder layers at Pratt's Falls, the preceding being more common in the softer.

P. itys. This species can be readily recognized by the fact that the revolving striae are *crossed* and *cancellated* by distinct concentric striae. Sometimes found at Pratt's Falls, more common in the shale near Skaneateles Lake.

Loxonema.—Two species of this genus also deserve similar mention.

L. Hamiltoniae is the most abundant. It has an elongated shell of usually not more than a dozen volutions. Its surface it marked by distinctly arched, longitudinal striae. Found at Pratt's Falls and Delphi.

L. Delphicola is not as abundant as the preceding, and differs from it in that its shell is broader, expanding more rapidly, its volutions are more convex, and its striae less curved. It is found at Delphi.

Other gasteropods are the *Cyclonema Hamiltoniae*, *Macrocheilus macrostomus* and *Bellerophon patulus*, *B. thalia.*

Brachiopods continue to be found in large numbers, the genus *Spirifera* being the most abundant. A few of the more common species are: *Spirifera granulifera*, *S. pennata*, *S. medialis*, *S. Tullia.* Other abundant species are: *Athyris spiriferoides*, *A. cora*, *Productella truncata*, *P. Tullia*, *Chonetes mucronata*, *Atrypa reticularis*, *Tropidoleptus carinatus.* Several species of *Orthis*, *Rhynchonella* and *Strophodonta* also occur.

Lamellibranchs.—If space and time permitted, we would speak of this class very elaborately. In the preceding groups we did not find it very well represented, but it now becomes quite abundant, lamellibranchs being fully as common as brachiopods. The handsome genus *Grammysia* is represented by a half dozen species, *Aviculas* occur in even greater profusion, the beautiful *Nucula*, the interesting *Goniophora*, with a host of other genera, are all found in this group. Some of the more abundant species are: *Grammysia arcuata*, *G. lirata*, *G. bisulcata*,

G. magna, *G. alveata*, *Actinopteria Boydii*, *Pterinea flabellum*, *Nucula Randalli*, *N. lirata*, *N. bellistriatus*, *Goniophora Hamiltonensis*, *G. truncata*, *Pterinopecten conspectus*, *P. regularis.*

There are also several species of pteropods found, they belong to the genera *Coleolus*, *Hyolithes* and *Conularia.*

Cephalopods continue to be found, although not as profusely as at the beginning of this period. The more common *orthocerata* are: *O. sublatum*, *O. crotalum*, *O. exile;* those more rarely found are: *O. spissum*, *O. constrictum*, *O. agea.*

The *Nautilus maximus* is another large cephalopod that is often found, neither are the *Goniatites discoideus*, or the *G. uniangularis* very rare.

Crustacea.—*Homalonotus Dekayi* is a large trilobite abundant in some of the harder layers. On account of the favorable character of these rocks for specimens of all kinds, it is not difficult to obtain entire specimens.

Phacops rana, which we found sparingly in the Upper Helderberg Period, is now found very abundantly.

Dalmanites calliteles is another trilobite that is quite abundant in the shale of this group.

Echinocaris punctata is a phyllopod that is often found in the blacker shales.

Fishes.—Occasionally a fish spine is the only trace of vertebrates that have as yet been found.

Plants.—Lepidodendrons, which in the Carboniferous became so plentiful, ferns, fucoides and other marine plants are all found in this group.

Tully Limestone.—Immediately overlying the Hamilton Beds we find an interesting limestone formation, having numerous exposures in our county. It is the Tully Limestone, and is interesting because it is the highest mass of limestone (geologically) in the State. It has not an extensive geological distribution, being found in only

a few counties besides our own. For this reason it is not always mentioned in works on geology as one of the divisions of the Hamilton Period.

Neither is its thickness as great as that of some of the limestone formations already mentioned. Its average thickness is not more than fifteen feet. The greatest thickness in our county, however, is considerably more than this, it being thirty feet thick in the ravine a mile northwest of Spafford Corners.

It is an impure, fine-grained limestone, with a dark blue color when freshly broken, which on long exposure to the weather becomes lighter colored. It is often accretionary in structure, breaking into small irregular fragments. The layers on separating sometimes show the fibrous appearance which was so common in the Lower Helderberg Period.

Among the fossils found in this group are two handsome species, which are wholly peculiar to it. They are the *Rhynchonella venustula* and the *Orthis Tulliensis.* Since these fossils have never been found in any other group, by their presence alone we can readily distinguish the Tully Limestone from any other.

The formation occurs sparingly in the towns of Fabius, Tully, Otisco, Spafford and Skaneateles. Some of the best places for studying it are: Tinker's Falls in Fabius; just south of Delphi; Ousby's farm, south of Tully; one mile south of Vesper; in the northeastern part of the town of Otisco, which is the most northern point where it occurs; one mile south of Borodino; and in any of the ravines near the head of Skaneateles Lake.

At Tinker's Falls the limestone is some fifteen feet in thickness. It forms a sort of shelf over which the water falls, and as the shale (Hamilton) which occurs below the limestone is more rapidly disintegrated by the atmospheric agencies than is the limestone, we have a natural cave ex-

tending back some ten or twelve feet from the front of the ledge. This cave, owing to the peculiar conditions by which it is being formed, is continually growing larger. This growth will, no doubt, at some future time be the cause of its destruction, for the limestone will not be able to sustain itself indefinitely when supported only by the sides and rear. When the strain upon the limestone, due to the force of gravitation, has become so great as to overcome the cohesion of its particles, the result will be disastrous to the cave. The appearance of the ravine would indicate that such has been the fate of a pre-existing cave at some time in the past.

The more common fossils outside of the two characteristic ones already mentioned are: *Spirifer Tullia*, *S. subumbona*, *Productella Tullia*, *Atrypa spinosa*, *Rhynchonella congregata* and *Chonetes logani* (variety) *aurora*. There are also several species of trilobites found, among them are: *Bronteus Tullius*, *Phacops rana*, *Dalmanites calliteles*, *Proetus Rowi* and *P. macrocephalus*.

The limestone is quarried in several places, and used for a building stone. It is also burned to a limited extent for lime. It makes a good but not a very white lime.

The Genesee Slate.—Immediately overlying the Tully Limestone we find a very black, fine grained, argillaceous shale, which is known as the Genesee Slate.

Its structure is somewhat slaty, hard and brittle, much more so than the Marcellus Shale; nevertheless, it is so uneven and fissile that we often hear it spoken of as the Genesee Shale.

It forms the tops of some of the higher hills in our southern towns, and may be easily recognized by its black color and its hard and brittle structure. We cannot easily mistake it, because it immediately overlies the Tully Limestone, which may always be recognized by its characteristic fossils.

Its thickness is usually not more than sixty feet; in the western part of Fabius, however, near where the excavations have been made for coal, it was considerably thicker, being about eighty feet thick.

Septaria, which were found so abundantly in the Marcellus Shale, are also found in this group, although very sparingly.

Fossils also are quite rare. The only trace which I have as yet been able to find is a small *orthis.* Several others, however, are known to occur in this shale.

This group may be studied in any of the hills in the southern part of Fabius or Tully, in Otisco near the head of the lake, and in Spafford.

A large amount of money has been spent in searching for coal in this mass. Its black color, together with an old tradition, saying that coal exists in the shale, have been the causes of considerable expenditures. In a few instances pockets of an impure variety of coal were found, its only importance, however, was to increase the mania for coal digging. The finding of these pockets of coal has also been the cause of considerable speculation. One of the theories most frequently met with, and one which seems to be sincerely believed by some of the people in that locality is the following: "Coal lying exposed to the atmospheric agencies for a considerable length of time has a tendency to deteriorate, or to 'lose its virtue,'" as they say. According to the theory all this slaty mass was once pure coal, which under the conditions mentioned has become valueless, except in patches to insignificant for profitable mining.

I did not succeed in finding any of these pockets of coal, but at many of the places where I stopped the people claimed to have seen and possessed specimens of it. Numerous inquiries to be shown some specimens of it al-

ways brought about a search for the article in question, but in no instance could any trace of it be brought to light.

THE CHEMUNG PERIOD.

This period, which is the next, is also the latest geological formation occurring in our county. On the tops of the highest hills, immediately overlying the Genesee Slate, will be found some sandstone flags interspersed with shale. These are the lower layers of the Chemung Period.

There are several sandstone layers, which are separated by a coarse shale. The sandstone, however, is usually fine-grained, and breaks with a smooth even fracture.

As the exposures of this formation in our county are few, and since it is quite difficult to reach them, situated as they are on the tops of our highest hills, we will find it easier as well as more satisfactory to study this group, and make our collections from exposures in Cortland county, just south of us. If, however, it is desirable to study the formation in our own county, exposures may be found in the northwestern part of Spafford and in the western part of Fabius.

Fossils are more numerous than in the Genesee Slate, although not as profuse as in the Hamilton Beds. The only ones which we have secured from our own county, however, are some crinoid stems, some fucoides, and a *strophomena*. All of these were secured in Fabius.

Some of the sandstones are used in making whetstones; the superior article sold by the Manlius firm is obtained from the Chemung Sandstones at Fabius. In Cortland county the flags are used to a considerable extent for sidewalks.

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